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Status of the Browns Bank scallop fishery for 1994 - Outlook for 1995

By

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[1]La présente série documente les bases scientifiques des évaluations des ressources halieutiques sur la côte atlantique du Canada. Elle traite des problèmes courants selon les échéanciers dictés. Les documents qu'elle contient ne doivent pas être considérés comme des énoncés définitifs sur les sujets traités mais plutôt comme des rapports d'étape sur les études en cours.

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ABSTRACT

During the past 6 years, catches from northern Browns Bank have risen with the exploitation of new grounds and year classes regularly recruiting to the fishery. The fishery is managed by quotas and meat count. The meat count was lowered from 55 to 40 meats per 500 g in 1994.

Catches and catch-rates more than doubled from 1993 to 1994. Research survey indices indicate good densities of scallops at the 40 meats per 500 g without blending and biomass estimates increasing 30% from 1994 to 1995.

A fishing scenario of 1,800 tons is proposed for northern Browns Bank considering the increase in the 1995 survey biomass. The south side of Browns Bank, where an exploratory survey (fall 1994) found minimum biomass of 40-count scallops, could presently contribute 50 tons to exploitation. Over the long term, it might not be possible to sustain this rise in catches.

RESUME

Au cours des 6 dernières années, les captures provenant de la partie nord du banc Browns ont augmenté pendant qu'on exploitait de nouveaux bancs et que des classes d'age recrutaient régulièrement à la pêche. Cette pêche est gérée par quotas et compte de chairs. On a réduit le compte de chairs de 55 à 40 par 500 g en 1994.

Les captures et les prises par unité d'effort ont plus que doublé de 1993 à 1994. Les indices d'inventaire de recherche ont montré de bonnes densités de pétoncles au compte de 40 chairs et cela sans mélanger. L'estimé de biomasse a augmenté de 30 % de 1994 à 1995.

On propose un scénario de pêche de 1,800 tonnes pour la partie nord du Banc basé sur l'estimé de biomasse de l'inventaire de recherche de 1995. La partie sud du banc Browns, où un inventaire d'exploration (automne 1994) trouva une biomasse minimale de pétoncles avec un compte de 40, pourrait contribuer 50 tonnes à l'exploitation en ce moment. A long terme, il semblerait difficile de soutenir cette hausse des captures.

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INTRODUCTION

During the 1970s and early 1980s, a scallop fishery took place on the southern part of Browns Bank and along the edge of the Bank at depths over 100 m. Landings ranged between 4 and 270 t with moderate catch-rates (Robert et al. MS 1989b). The 'recent' fishery started in 1989 on the northern part of Browns Bank in areas not previously fished. During the past 6 years, catches have risen as new grounds were exploited and year classes were regularly recruiting to the fishery.

Since 1989, the fishery in Scallop Fishing Area 26 (4X) has been managed with a catch limit and a meat count set at 55 meats per 500g. In 1994 the entreprise allocation management regime was implemented for each of Browns and German Bank scallop stocks. At industry's request the meat count was lowered from 55 to 40 meats per 500 g for the western Scotian Shelf including Browns Bank and German Bank. The 1994 TAC for Browns Bank was increased to 1,400 t from 600 t in 1993 (Fig. 1). Research survey indices indicated good densities of scallops at the lowered count of 40 meats per 500 g and this, without considering blending practices. Catches and catch-rates more than doubled from 1993 to 1994.

This document presents information with respect to possible fishing scenarios for 1995. Given that the fishery on the north side of Browns Bank is only 6 years old, recommendations on fishing scenarios have been based on biomass estimates from the spring stock surveys.

Three fishing scenarios are presented: 1) An estimated catch of 1,800 t could be taken on the north side of Browns Bank based on the average tow biomass of the 1995 spring stock survey. 2) Following the exploratory work conducted on the south side of Browns in the fall of 1994, the stock biomass harvestable at the 40 meat count could be incorporated into a catch figure for 1995. This would increase the catch figure to 1,850 t. 3) A proposed catch higher than 1,850 t would borrow from future harvestable yield to some extent but the meat count should partially mitigate this loss of yield.

METHODS

Fishery Information

There are two sources of information to estimate the respective catch contributions of scallop fishing grounds on the Scotian Shelf. Offshore scallop landings are now monitored at dockside by an independent agency. The monitoring replaces sales slips that were issued by fish buyers. Amounts landed and (NAFO) areas fished are then compiled by the Statistics Division, Department of Fisheries and Oceans, Halifax. As well, the origin of the catch is derived from logbooks. Discrepancies occasionnally occur between statistical and logged catches as NAFO sub-subareas may cut a major scallop bed in two (Robert et al. MS 1984). The scallop fishery on 'Browns Bank' actually takes place in 2 statistical fishing areas, Browns Bank per se (NAFO sub-subarea 4Xp) and the Tusket area (NAFO sub-subarea 4Xo). For convenience, landings, catches, and effort data have been combined (Table 1).

All vessels (over 25.5 G.T. or 14 m L.O.A.) fishing the Scotian Shelf are required to keep logbooks. Daily log records supply information on the catch and its location and fishing effort such as hours fished, width of gear, and number of crew. Catch-rate estimates are then computed when complete effort data (location, hours fished, gear, etc.) are provided with respect to the catch (Class 1 data). Total effort may be estimated according to the effort that generated the Class 1 catch. Removals from a specific scallop bed is determined assuming that the catch with known location is representative of the total catch from that bed.

Scallop Fleets

Only the deep-sea fleet, vessels over 19.8 m L.O.A, is involved in the recent fishery on the north side of Browns Bank. A New Bedford offshore scallop drag is used which varies in width from 3.96 to 4.88 m. Two drags are fished simultaneously, one on each side of the vessel.

Catch Sampling

Sampling of the catch is sporadic and does not meet target levels to sample the catch adequately. Port coverage varies greatly, from none for southwest Nova Scotia ports like Saulnierville to somewhat fair for the Lunenburg - Riverport based fleet. Not all ports are necessarily involved in any particular Scotian Shelf fishery. Efforts are being made to collect data from the Browns Bank fishery given its prospects. At landing, 9 500-g samples are taken from the catch to represent one sample per day fished. Scallop meats are weighed to the 0.01g. Upon analysis, frequency distribution of meat weights in 2-g interval is developed. Meat weights have also been converted to shell heights after the allometric relationship found in table 2 and the heights clustered in 5-mm increments to compare with survey data.

Survey Procedures

The catch distribution from the previous fishing season derived from log records for each fishing ground is used to stratify survey stations which are randomised within a low, medium, and high stratum. An exploratory stratum may occasionnally be added. Annual surveys are carried out in May. The Browns Bank fishery expanded eastward in early 1994. The area now fished has increased by 100 km^2 to approximately 600 km^2. A new survey series (CK) began in 1994; this was the last year for the old series (P). There does not appear to be important differences between the two series for height classes over 100 mm.

An exploratory survey took place in September, 1994 to estimate stocks in locations not recently fished on Browns Bank. Areas sampled were determined by plotting locations fished between 1976 and 1985. The extent of scallop beds along the edge of the Bank was investigated. Survey sites were selected according to a grid pattern of LORAN Time Differences, 2-3 nautical miles apart.

The survey gear was a 2.44 m wide New Bedford offshore drag (75 mm ring size) lined with 38 mm stretch mesh polypropylene netting. Tows were of ten minutes duration; distance towed was determined from the continuous recording of Loran C bearings and in 1995 with GPS (Global Positioning System) positions via a microcomputer or, exceptionally, from locations taken at the start and the end of the tow. Catches were later standardised to a tow length of 800 m. For each tow, the following data were recorded: 1) shell heights in 5 mm intervals for all live scallops and cluckers (shells with both valves still attached at the hinge); 2) tow location (Loran C bearings); 3) depth (m); 4) compass bearing for direction of tow; 5) duration of tow (minutes); 6) substrate type; 7) fullness of the drag (count of the number of vertical rings covered by the catch);

and 8) total scallop catch as a round weight (kg).

Standardized survey catch-rates were contoured to represent the spatial distribution of the scallop aggregations following a procedure described in Black (MS 1988). In summary, the contouring procedure operates as follows. Data points describe a three dimensional surface with latitude, longitude, and number of scallops per tow to be plotted. A surface is formed by defining Delaunay triangles (Watson 1982); the data points become the vertices of triangles connecting nearest neighbour points. The surface between adjacent contour levels, in this case the relative abundance of scallops, is represented by darkening shades of grey. Contours may be smoothed by interpolating the surface using the inverse weighing of gradients (slopes of triangles). The sides of the Delaunay triangles are divided into equal segments (chords) to establish the interpolation points. For example, dividing the sides into 4 segments gives 16 subtriangles. The interpolation points become new vertices. This method assumes that the data points near the point in question contribute more than distant points (see also Watson and Philip 1985). Each triangle is assumed to have a flat surface. The summation of the volumes of all triangles under the contoured surface is equal to the total volume, a potential abundance estimate for the survey area. The degree of interpolation will affect the volume estimates. Experimental work indicates that volume estimates stabilise with a minimum of variation (5%) (Robert et al. MS 1989a) after 16 or more subtriangles.

Fishery Performance

Catch data were plotted from locations provided in logbooks to investigate the concentrations of fishing activity presumably related to abundance, hence location of scallop beds. Log returns for the Browns Bank fishery are excellent with over 90% class 1 data. Isolines of commercial catch-rates are drawn and surfaces contoured as for the survey catch-rates, thus mapping the distribution of scallop beds on the Bank.

Relevant Biological Information

A growth rate function is not yet available for scallops on the north side of Browns Bank. On the south side where the exploratory survey took place, shell heights were clustered into age groups according to a Von Bertalanffy equation ($Height_{\infty} = 109.91mm$; $t_0 = 1.44$; $k = 0.28$). Meat weights for selected shell heights are provided in table 2. They have been derived from an allometric equation including all available data. North side values are -10.97 for the intercept and 2.91 for the slope; -15.05 and 3.74 respectively for the south side. Meat count values for selected shell heights of the south side of Browns are also compared to the shallow waters on the north side of the Bank. For a given shell height, yield is smaller on the south side.

Biomass estimates

Given the short history of this fishery, an analytical assessment is not yet possible. Survey data provide relative biomass estimates for scallops at height. Shell height classes may lead to a more precise estimate, the class interval being smaller than age classes. Survey tow biomass of scallop heights equal to 55 meats per 500 g or less (or height $\geq$ 100 mm) was used to establish fishing scenarios. The meat count figure was decreased from 55 to 40 (or height $\geq$ 110 mm) in 1994. Recommended TAC levels have been rising proportionally as survey biomass estimates were increasing. This strategie is thought conservative as the above meat counts are considered without blending and allowance is not made for expansion into new fishing areas.

The 1994 scenario had 2 particularities. The lowering of the meat count from 55 to 40 meats per 500 g that year, required a survey biomass estimate at the lower count for 1994 and compare it to what it would have been in 1993 to maintain the prorating of TAC levels. The survey series changed in 1994. Since the difference between the biomass estimate from the old series (P)

and the new series (CK) was less than 20%, the mean of the 2 series' estimates was used in the interest of timeliness.

RESULTS

The Fishery

A historical profile of the Browns Bank fishery is presented in Robert et al. (MS 1994). Suffice to say here that the resumption of the scallop fishery on Browns Bank in 1989 has taken place with the discovery and further expansion of scallop beds located in the northwestern section of the Bank (Fig. 2). The pre-1989 Browns Bank fishery exploited beds on the southern part of the Bank, along the edge, and adjacent depths over 100 m on the north side. Fishery characteristics of the Browns Bank fishery from 1979 to the present are presented in table 1.

The 1994 fishery had the best catches and catch-rates since 1989. Catch levels more than doubled from 1993 to 1994 (Table 1) with catch-rates following the same trend. Accumulated biomass on beds previously exploited and new fishing areas further to the east (around longitude 65.9 °W) contributed to the increase in catches, 45 and 55% respectively. It is estimated that in 1993, 172 km^2 of scallop beds had very high catch rates; a year later, 448 km^2 had very high catch-rates (Fig. 2). 1994 was the first year the fishery operated year round (Table 3). Smaller TAC's in previous years had shortened the duration of the fishery. The bulk of the 1994 catch came from the third quarter (Fig. 3a). Catch-rates throughout 1994 ranged from 1.1 to 3 kg/crhm (Fig. 3a). At its lowest point on a monthly basis, CPUE was around 1 kg/crhm to pick up in the fall after the completion of spawning. Fishermen appeared to be targetting scallops with large meats near the end of the fishing season as indicated by low monthly meat counts. Preliminary results for 1995 indicate that, for the first 5 months of the year, 1995 catch-rates are comparable or better than 1994 (Fig. 3b).

Another new feature of the 1994 fishery was the lowering of the meat count from 55 to 40 meats per 500 g. Given the abundance of large meated scallops, industry requested this reduction. It was not detrimental to the fishery. The average meat weight landed has been rising (Table 4) ever since the fishery resumed in 1989. From an annual meat count of 56 (average number of meats per 500 g) in 1989, it went from 34, to 32, to 25 respectively, over the last 3 years. The monthly profile of counts landed in 1994 (Fig. 3a) showed a decreasing trend overall suggesting no shortage of well meated scallops.

Figure 4 shows the annual frequency distribution of the catch at height from the converted meat weight data. Seasonal effects will be included later. Catch-at-age information is not yet available. The modal height in the catch has steadily increased from 92.5 mm (mid-point of increment) in 1989 to 117.5 mm in 1994. The mode jumped from 107.5 to 117.5 from 1993 to 1994 illustrating the importance that large scallops had in the 1994 fishery.

Research Surveys

Previous surveys (1983-1985) had found high concentrations of age 2 juveniles in a well delimited area of southeastern Browns Bank. However, these year classes did not contribute to a fishery renewal. Very heavy mortality rates appear to have been experienced by possibly 3 successive year classes of scallops on the southern edge of Browns Bank (Robert et al. MS 1986). Survey work was interrupted after that.

Stock surveys resumed after the fishery started on the north side of Browns Bank. The post-1990 series of surveys show a greater abundance of both recruits and prerecruits on the grounds recently exploited compared to the grounds historically fished (Robert et al. MS 1986). The 1994 survey shows the build up in abundance of larger scallops (Fig. 5). The mode of prerecruits is followed from 1994 to 1995. The mode of large scallops has shifted slightly to the right according to the 1995 survey. Scallops with shell height over 110 mm correspond to a 40 meat count (per 500 g) without blending. The number / tow of these recruits was greater in 1995 than 1994 by almost 20%. The increase is attributed to an accumulated biomass on grounds previously fished and to a biomass not yet exploited in new fishing areas. The bottom graph in figure 5 shows a 1995 survey height profile but only for the area also covered in the 1994 survey. Areas previously fished account for 64% of the survey biomass while new areas provide 36%.

Since a growth curve is not available for this location on Browns, tow biomass from survey results are presented according to 5-mm shell height intervals (Table 5). The area surveyed has expanded over the last 5 years, therefore abundance at height is not directly comparable between years. Using the meat weight - shell height allometric relationship developed for this scallop bed, the biomass per standard tow for scallops over 100 mm is given in table 5. All scallops above 100 mm readily meet the 55 meat count without blending; 110 mm equals a 40 meat count. Tow biomass doubled from 1991 (553 g) to 1992 (1,162g) to remain about the same in 1993. An adjustment in the computation of the tow biomass was made in 1994 with the introduction of the 40 meat count. The abundance of scallops >110 mm (under 40 count without blending; mean tow biomass 2,257g) led to the large increase in the TAC, from 600 to 1,400 t in 1994. Of the recent (1991-1995) survey data, the 1995 biomass figures are the highest. The survey biomass corresponding to a count of 40 or less has increased by 30% from 1994 to 1995 (Table 5). Therefore, TAC levels could rise by 30% from 1994 to 1995. The figures are not corrected for dredge efficiency on those substrates.

Exploratory Survey

An exploratory survey of grounds fished historically and potential scallop beds along the southern edge was conducted in September, 1994 at industry's request. 122 locations (Fig.6) were surveyed from the commercial scallop dragger 'Cape Keltic'. The area covered was approximately 950 km^2. Results were stratified a posteriori according to depth and/or bottom type. Table 6 gives the mean number at age per standard tow while figure 7 maps the distribution of ages 3 to 8+. Generally speaking, scallops were present in a main bed and along the edge going westward, stratum II and III. Densities were much lower in stratum IV and V. Older recruits (age 8+) were in sizable quantities along the edge but this area was small. Good numbers of recruits, especially ages 4 and 5 (in stratum II) were found in concentrations of more than 500 per tow (Fig.7). Prerecruits (age <4) were found in the main bed and along the edge in moderate to low quantities. Growth-rate in this area is slower than on top of the Bank. Also for a given shell height, the meat weight is smaller, hence a higher count (Table 1). To compare the results of the exploratory survey with results from surveyed areas to the north of the Bank, the data (stratum 2 and 3) were also plotted as number / tow according to 5-mm shell height intervals (Fig. 8). In contrast to survey results from the fished areas, there are very few scallops corresponding to a count of 40 or less (shell height 110 mm) in the exploratory area. That relates to a tow biomass of 113 g. But there is an important mode of prerecruits at 70 - 75 mm shell height; they are at least 3 years from recruitment to the fishery.

DISCUSSION AND CONCLUSION

Despite increasing removals from Browns Bank since the fishery resumed in 1989, catch-rates keep going up. The fishery is taking place on expanding grounds. Expansion may continue given the size and abundance of beds observed during the 1994 fall exploratory survey. However, these stocks grow more slowly and for a particular shell height, meats are smaller than on beds from the top of the Bank. Aggregations of commercial size scallops were also found on the edge of the Bank. On top of the Bank, biomass appears to have increased on beds that have been exploited since 1989 as shown by the presence of large scallops (over 120 mm shell height) in the catch and in research surveys. There also appears to be more year classes recruiting to the fishery. The significant increase in catch-rates at the 40 meat count attest to the stock abundance.

Catch-rate indices, both from research surveys and the commercial fleet, have been steadily increasing (Fig. 9) since the fishery started. The 1995 survey index is greater than 1994 by 30%; it is the highest encountered to date. It is somewhat conservative because it considers only the biomass of scallops going to a count of 40 without blending. Hence one of the proposed fishing scenario at 1,800 t (1,780 rounded to the nearest 50 t). Commercial CPUE's doubled from 1993 to 1994. For the first half of 1995 preliminary results indicate catch-rates comparable to or better than 1994. Fished areas with very high catch-rates more than doubled in size from 1993 to 1994. The lowering of the meat count from 55 to 40 per 500 g did not cause any difficulties with respect to blending practices. Over the last 3 years, the actual count in the catch has gone from 34 to 25 (meats per 500 g). Also, the 1995 research survey has observed a good pulse of prerecruits well distributed over the Bank.

The south side of Browns Bank, where an exploratory survey was conducted last fall, does not carry, at the present time, great quantities of scallops larger than 110 mm corresponding to a 40 count. This area may only contribute a small amount to the stock biomass. Hence the second scenario proposed, adding a contribution of 50 t to the 1,800 t coming from the north side of the Bank for a total of 1,850 t. Fishing scenario(s) with a catch limit higher than 1,850 t would borrow from future harvestable yields. But the meat count set at 40 meats per 500 g should mitigate this loss of yield to some extent.

Over the long term, it might not be possible to sustain the rise in catches. Once the fishery can no longer expand over new grounds on Browns Bank, it will rely solely on recruitment for stock renewal.

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Table 1.- Fishery characteristics for the Browns Bank - Tusket area (NAFO 4Xp and 4Xo) for the deep-sea fleet. Landings and catches are in t of scallop meats. Landings are from Statistics Division, Fisheries and Oceans, Halifax. Catches are from logbooks. Effort is calculated from Class I data. h: hours; crhm: crew-hour-meter. Prior to 1989 the fishery was conducted on the south side of Browns Bank.

Year	Landings (t)	Catches (t)	Effort		CPUE	
			h 10^3	crhm 10^3	kg/h	kg/crhm
1979	73.05	91.60	1.23	169	74.77	0.541
1980	271.40	246.70	4.25	572	58.06	0.431
1981	25.34	14.26	0.17	22	81.73	0.645
1982	161.62	154.27	2.52	315	61.23	0.489
1983	106.02	87.94	2.02	240	43.57	0.366
1984	27.17	18.19	0.62	72	29.33	0.253
1985	6.93	16.38	0.33	39	50.44	0.425
1986	4.64	4.00	0.06	7	68.50	0.576
1987	0.00	0.00	0.00	0	-	-
1988	4.22	5.16	0.02	3	214.96	1.808
1989	337.34	320.07	3.51	473	91.18	0.677
1990	181.39	205.68	2.75	382	74.94	0.538
1991	202.05	201.32	2.40	361	83.84	0.557
1992	453.80	453.61	3.98	599	113.85	0.757
1993	575.43	574.60	4.51	693	127.40	0.829
1994	1403.59	1402.73	5.37	831	261.15	1.688

Table 2.- Shell height (mm), meat weight (g), and meat count per 500 g for scallop grounds on Browns Bank. Allometric relationship calculated from 600 scallops collected from May to October for the north side of Browns and from 359 scallops collected during the September survey for the south side.

	North side		South side	
Shell height (mm)	Meat weight (g)	Meat count	Meat weight (g)	Meat count
70	4.1	122	2.3	214
75	5.0	100	3.0	165
80	6.1	83	3.8	130
85	7.2	69	4.8	104
90	8.5	59	6.0	84
95	10.0	50	7.3	68
100	11.6	43	8.9	56
105	13.4	37	10.6	47
110	15.3	33	12.7	39
115	17.4	29	15.0	33
120	19.7	25	17.6	28
125	22.2	22	20.4	24
130	24.9	20	23.7	21

Table 3.- Catches (tons of meats) for the Browns Bank / Tusket area per quarter (Q) of the year. Before 1993 the TAC was for the whole of NAFO 4X.

Year	Q1	Q2	Q3	Q4	TOTAL	TAC
1989	-	25.47	231.46	63.14	320.07	400
1990	-	-	195.17	10.51	205.68	200
1991	-	-	201.32	-	201.32	220
1992	-	395.30	58.31	-	453.61	450
1993	-	188.86	356.87	28.87	574.60	600
1994	152.69	178.22	742.77	329.05	1402.73	1400

Table 4.- Nature of the catch from Browns Bank / Tusket area determined by analyses of scallop meat weights since 1989.

	% catch examined	meat weight (g)			
	catch landed	mean	min	max	s.e.
1989	0.0388	8.93	3.70	49.90	0.01
1990	0.0022	10.43	4.13	42.79	0.07
1991	0.0115	12.65	4.69	49.46	0.04
1992	0.0187	14.62	5.71	48.36	0.02
1993	0.0131	15.59	5.23	62.90	0.02
1994	0.0129	19.95	6.10	61.11	0.03

Table 5.- Browns Bank stock surveys. Estimated biomass (g) per standard tow for 5-mm shell height intervals over 100 mm corresponding to a meat count (MC) as indicated, at survey time. Figures not corrected for gear efficiency. In 1994, P stands for results from the "Prince' survey (old series); CK for the 'Cape Keltic' survey (new series). SH: shell height in mm.

	Shell height intervals							total biomass (g)	
	100-105	105-110	110-115	115-120	120-125	125-130	130-135 +	MC<55 SH ≥100	MC<40 SH ≥110
1991 survey	190	147	84	57	38	33	4	553	
1992 survey	336	314	262	160	65	20	5	1,162	
1993 survey	390	265	152	99	57	22	8	993	
1994 survey (P)	751	987	848	575	404	240	57	mean	mean
1994 survey (CK)	888	981	892	596	447	359	95	4,060	2,257
1995 survey	586	763	835	749	542	471	273	4,218	2,870

Table 6.- Average number of scallops at age per tow for the Browns Bank exploratory survey, September, 1994. Strata were defined a posteriori according to depth and substrate. N: number of stations in a stratum. Mean is total weighted average for the 122 stations.

		Age (years)								
Stratum	N	3	4	5	6	7	8	9	10	11^{+}
I	10	0	0	0	0	0	0	0	0	0
II	49	79	167	174	101	50	19	8	2	5
III	22	58	72	94	90	86	71	52	30	77
IV	30	16	17	4	2	1	1	0	0	4
V	11	3	6	2	0	0	0	0	0	0
mean	122	46	85	88	57	36	21	13	6	17

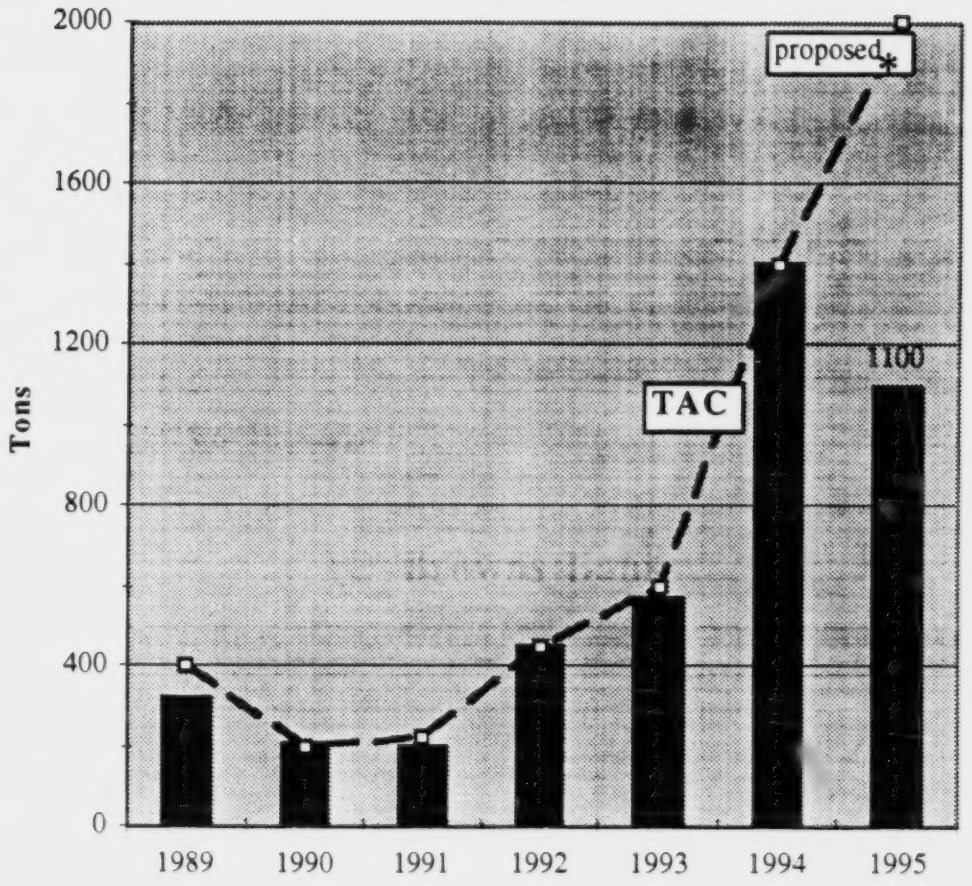

Figure 1.- Catches for the recent fishery on Browns Bank. 1995 catches to the end of May are preliminary. The proposed 1995 TAC is indicated.

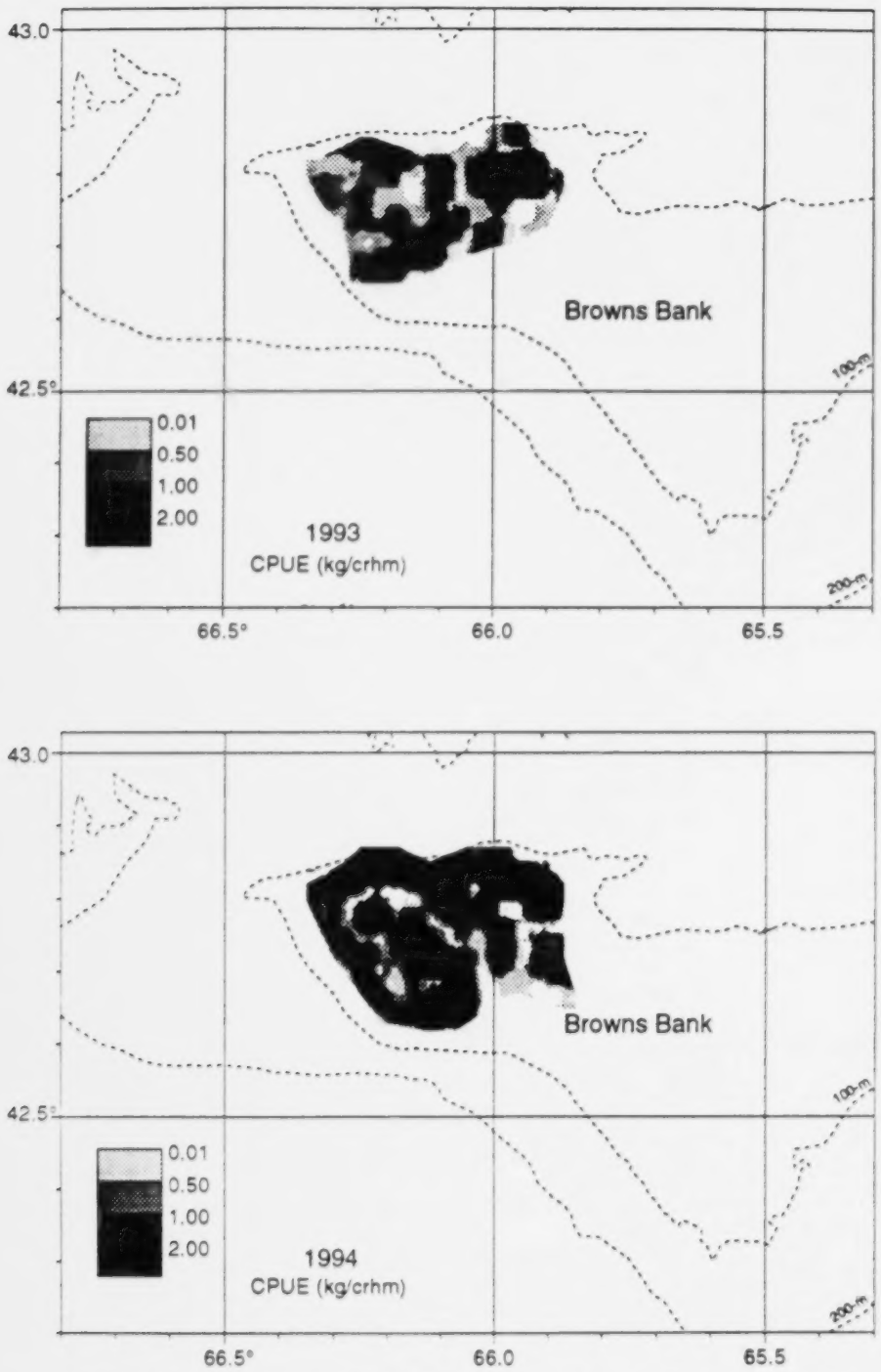

Figure 2.- Distribution of commercial CPUE on Browns Bank per year. The darkest contour represents 2+ kg/crhm.

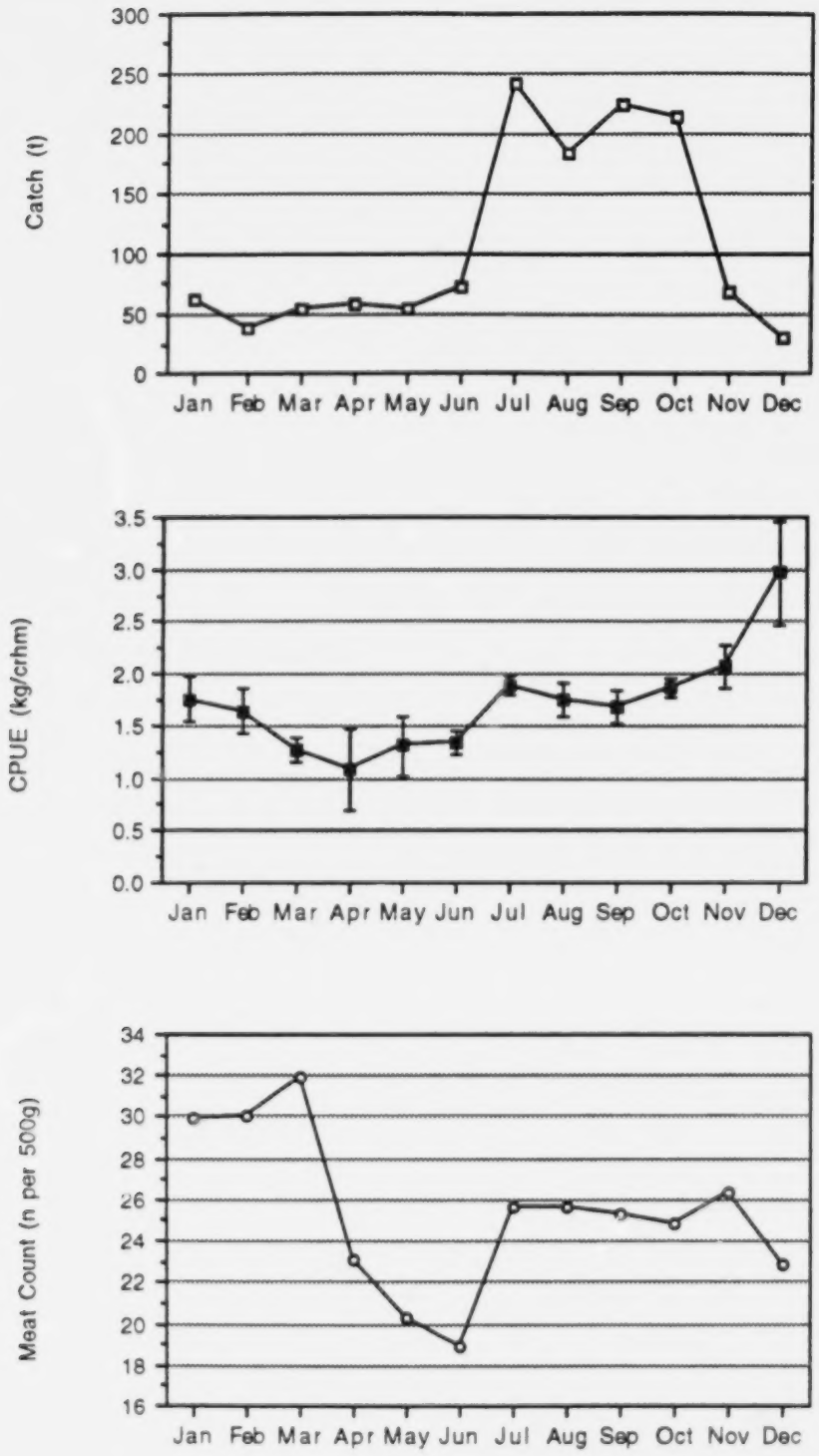

Figure 3a.- Monthly profile of catches (tons of meats), CPUE (kg/crhm), and meat counts (number of meats per 500 g) for the 1994 Browns Bank fishery. CPUE values are provided with s.e.'s.

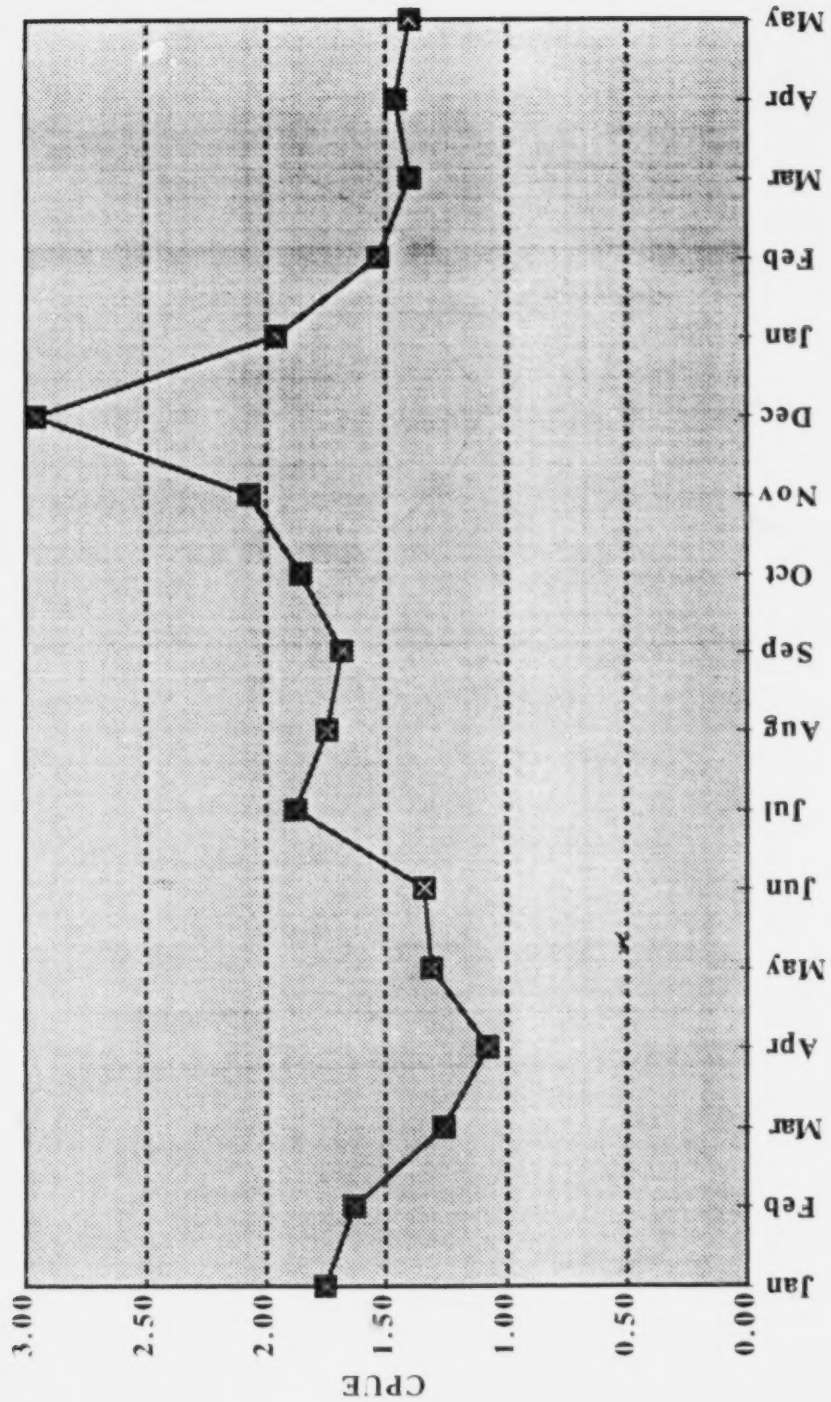

Figure 3b.- Monthly profile of CPUE from January 1994 to May 1995 inclusive. Data for 1995 are preliminary.

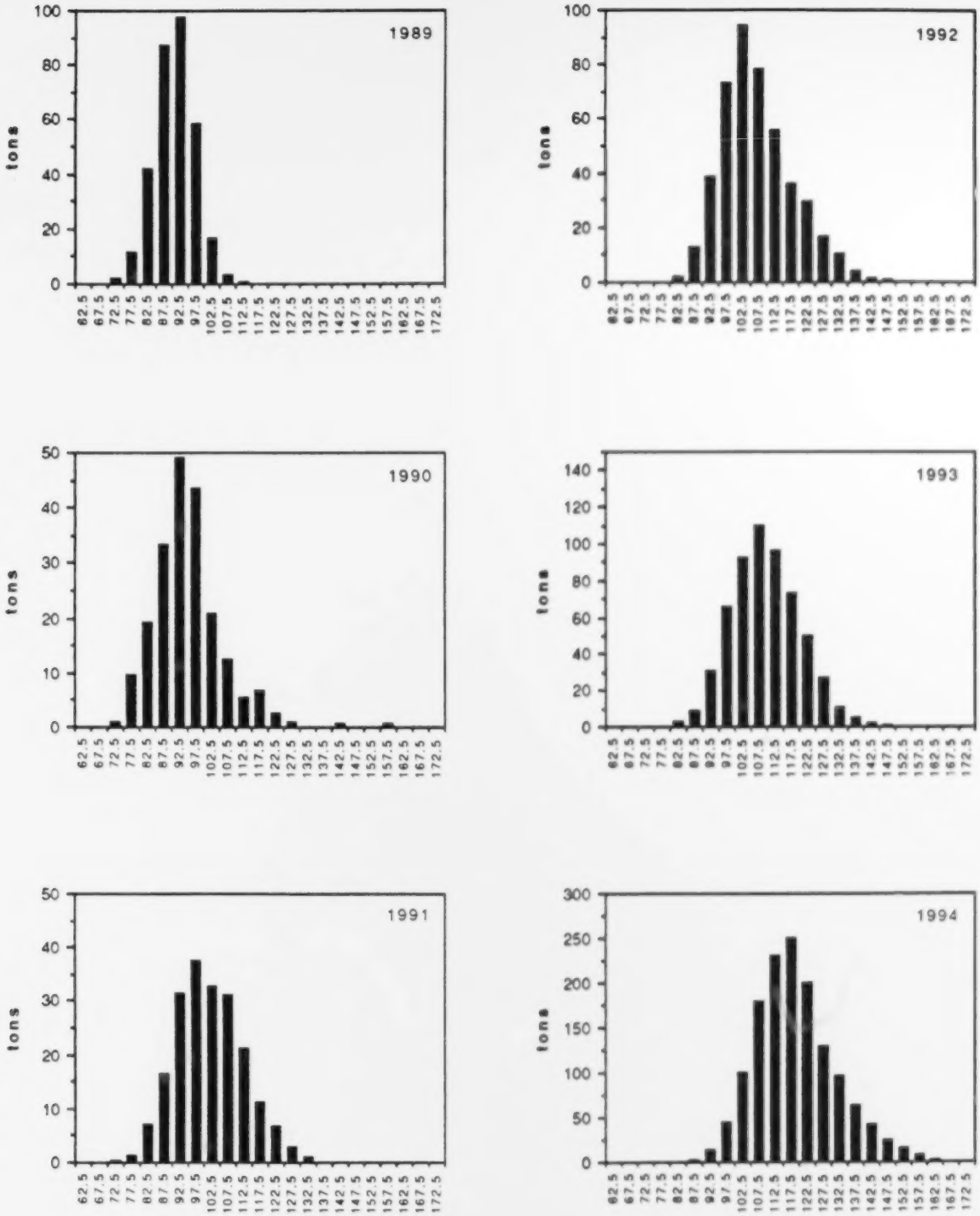

Figure 4.- Distribution of the catch according to 5-mm shell height increment from port sampling data for Browns Bank since 1989.

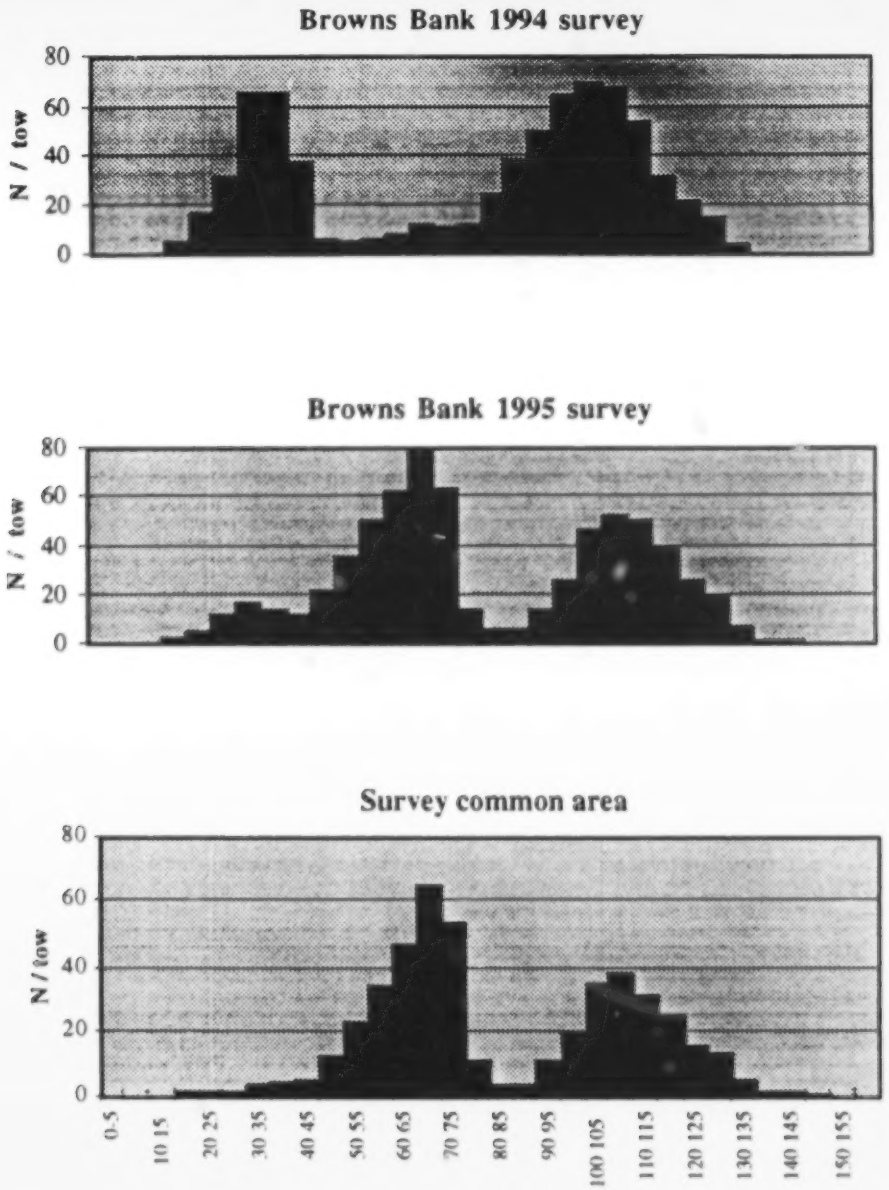

Figure 5.- Number of scallops per tow according to 5-mm shell height increment for the 2 most recent Browns Bank stock surveys. The bottom graph shows the height profile for the survey area common to both 1994 and 1995. A meat count of 40 corresponds to a shell height of 110 mm.

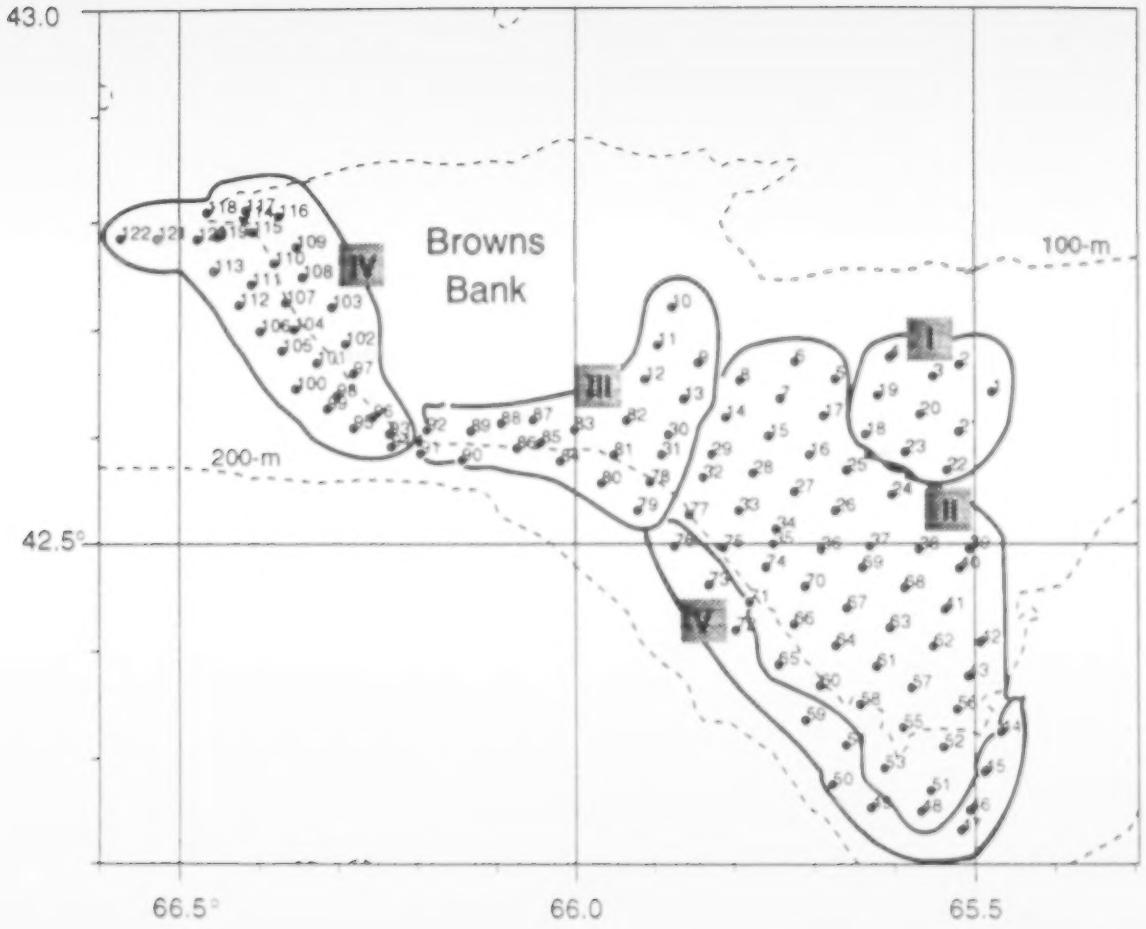

Figure 6.- Locations of stations of the exploratory survey of Browns Bank, September 1994. Strata are identified with a Roman numeral.

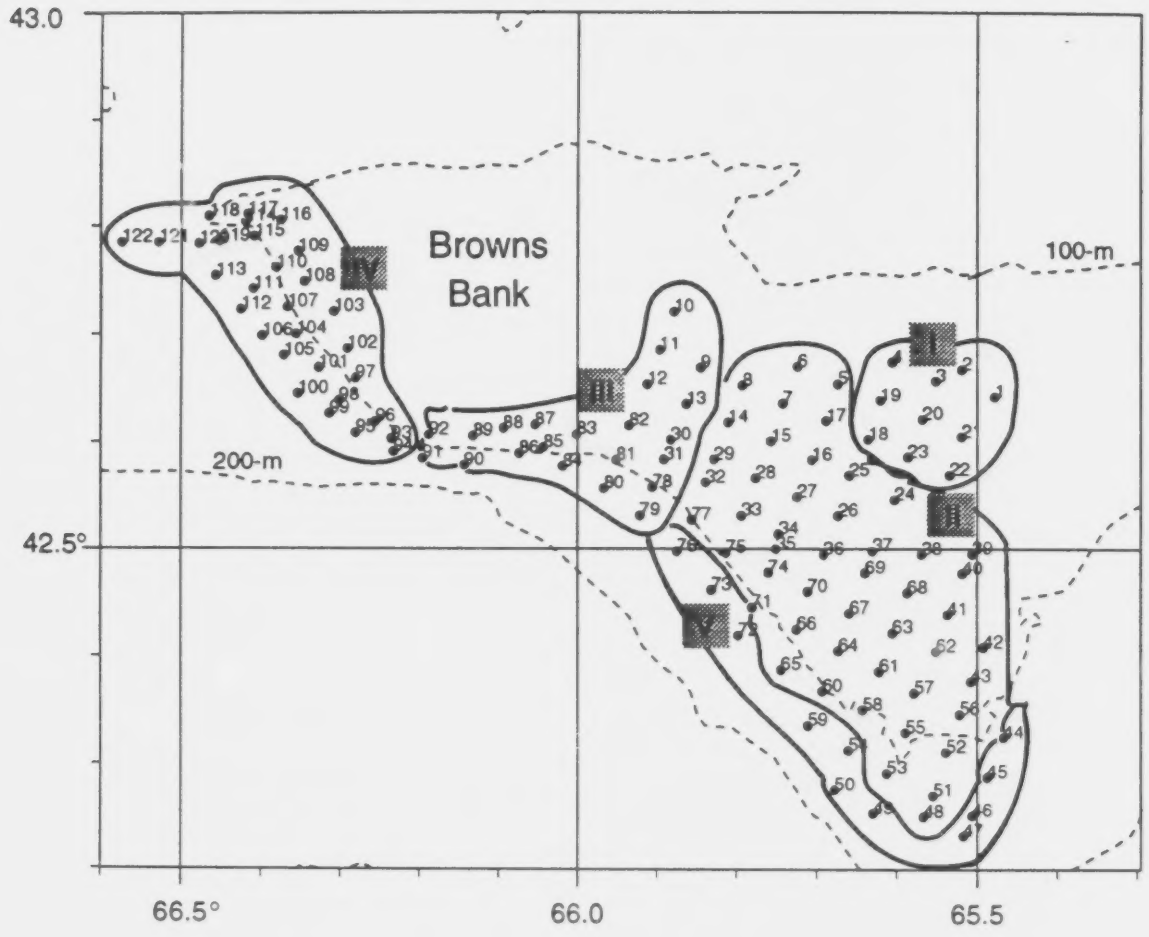

Figure 6.- Locations of stations of the exploratory survey of Browns Bank, September 1994. Strata are identified with a Roman numeral.

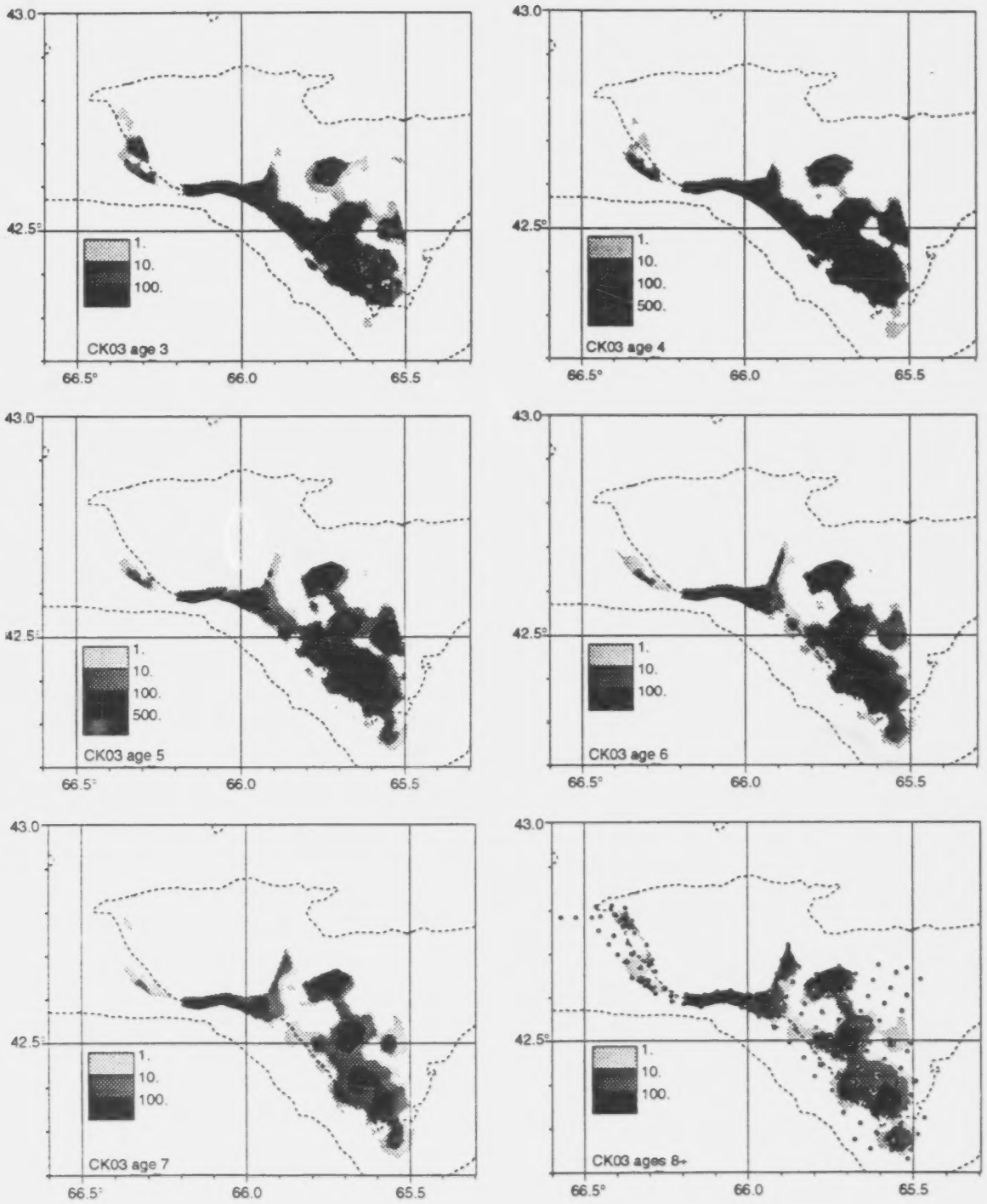

Figure 7.- Scallop distribution for ages 3 to 8+ from the Browns Bank exploratory survey (September, 1994). Sampling stations are on the map for age 8+. The shading scale (lower left corner of each map) represents the number of scallops per tow. The dashed lines are the 100-m and 200-m isobaths.

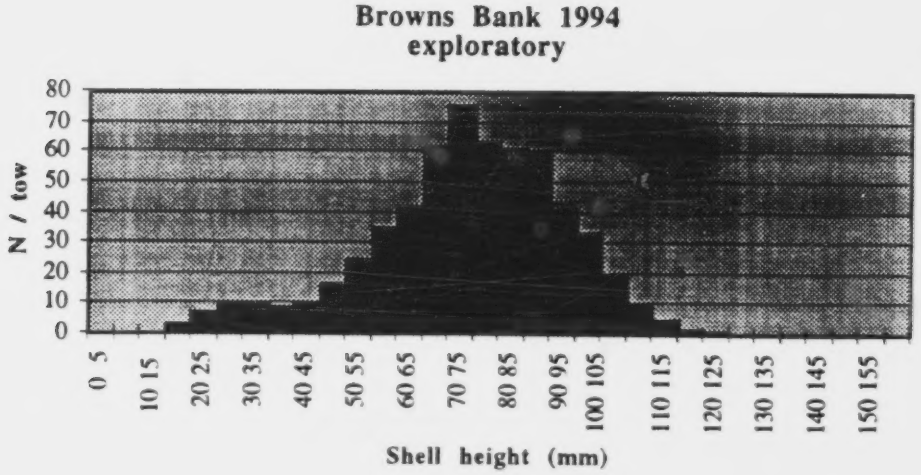

Figure 8.- Number of scallops per tow (stratum 2 and 3) according to 5-mm shell height increment for the exploratory survey on the south side of Browns Bank, September 1994. A meat count of 40 corresponds to a shell height of 110 mm.

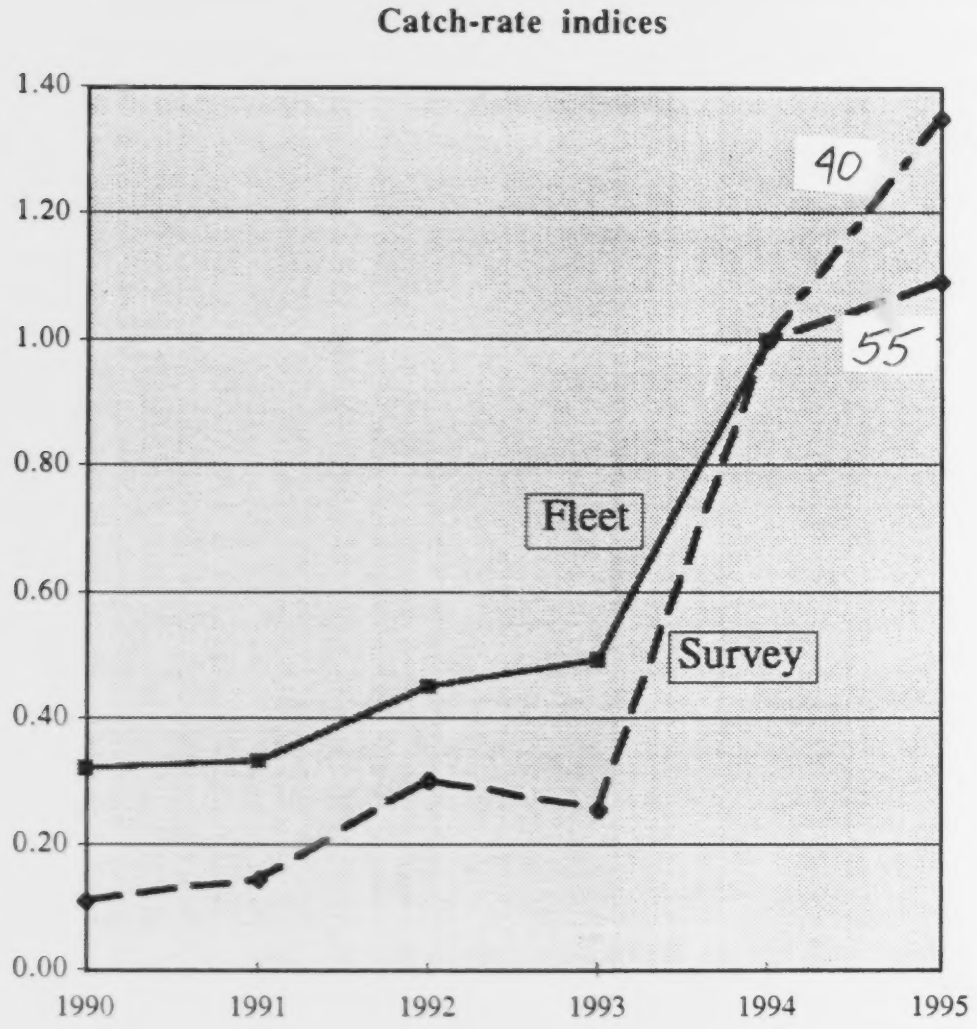

Figure 9.- Browns Bank catch-rate indices for the commercial fleet and research surveys. "55" indicates survey catch-rates corresponding to a count of 55 meats per 500 g; "40", a count of 40 meats per 500 g.